Ground System Overview

GS SDR Section 6

Ken Lehtonen

GLAST Ground System/Operations Manager

Outline

- *Ground System/Operations Organization*
- *Major Changes Since SRR*
- *GLAST Ground Systems SRR RFA's*
- *Ground System Requirements Flow*
- *Ground System Documents…*
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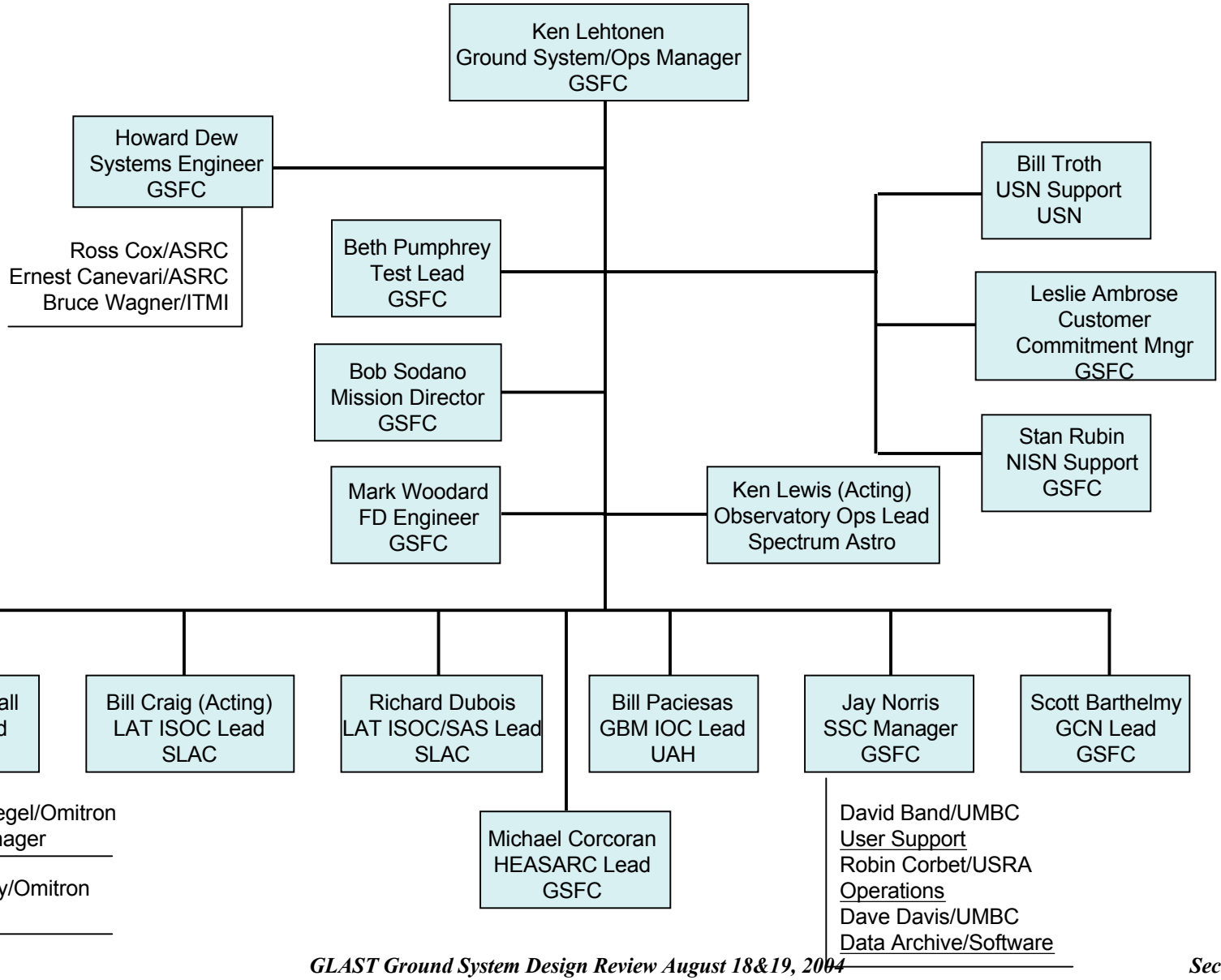
- *Architecture Summary*
- *GSRD Requirements Statistics*
- *Programmatics*
- *Integrated Schedule*

For more information: URL: http://glast.gsfc.nasa.gov/

Ground System/Ops Organization



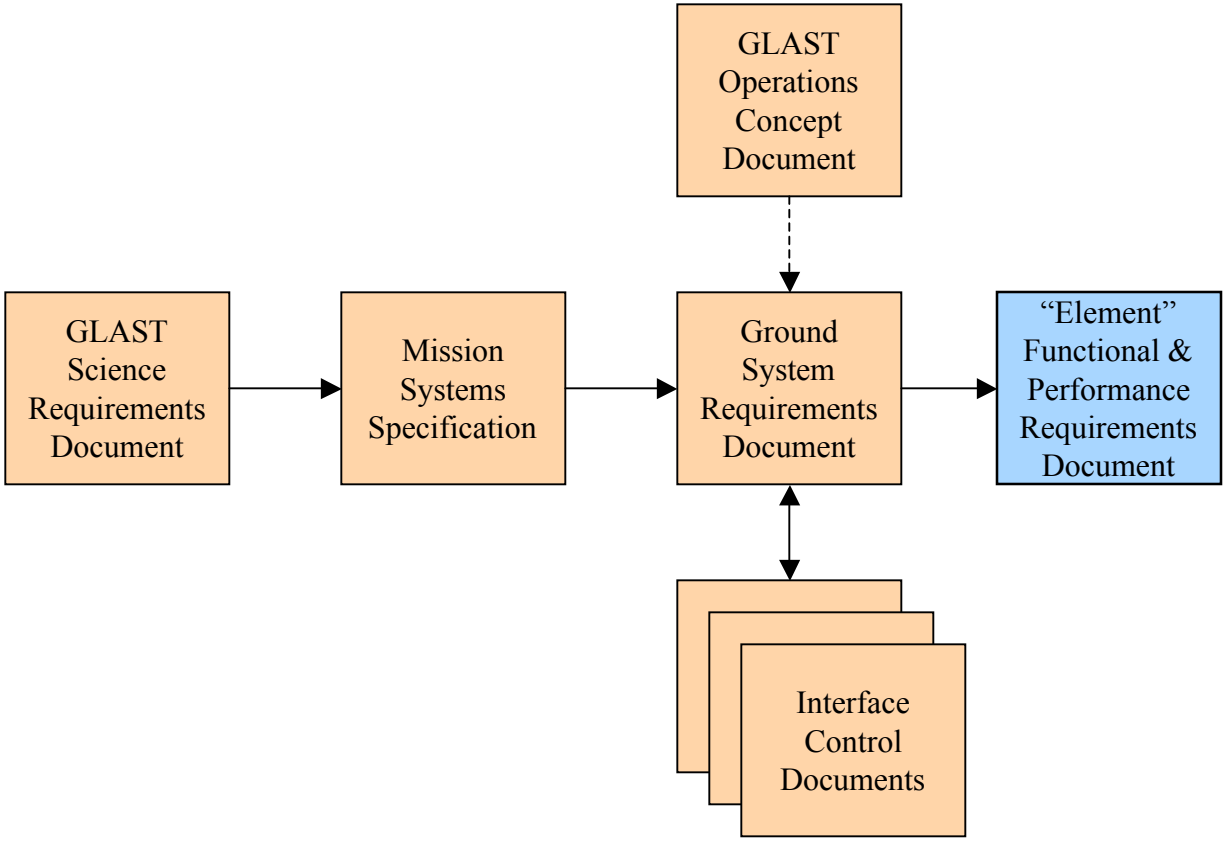
Major Changes since SRR

- ***Ken Lehtonen (581) selected to replace Mike Rackley as Ground System/Operations Manager***
- ***Spacecraft RF Design Change: Ku-band TDRSS science downlink replaces X-band GN downlink (Malindi removed)***
  - *Front-end required at WSC, new interface to MOC (GFEP)*
  - *Attitude-dependent TDRSS scheduling required*
- ***LAT instrument data rate increase by 4X***
  - *Network bandwidth and data storage adjusted, latencies understood*
  - *Onboard recorder storage increased to 160Gb*
- ***Command and Telemetry Simulator (CTS) has been removed***
  - *Many of the CTS capabilities (SAI-provided) have been moved to the PSS (GSFC-developed) to provide required test capabilities sooner*
  - *MTS is being delivered sooner and in 2 installations to compensate*
- ***Backup Ground Station selected: USN in, Wallops & Merritt Island out***
  - *USN's South Point, Hawaii and Dongara, Australia stations*

GLAST Ground Systems SRR RFA's

RFA Number	Title	Originator	Status
NO._G001	TDRS Scheduling	A. Levine	Closed - Approved by Review Board
NO._G002	International Agreements	G. Iona	Closed - Approved by Review Board
NO._G003	GSSC Peer Review	R. Schweiss	Closed - Approved by Review Board
NO._G004	General Requirement Scrub	M. Butler, S. Scott	Closed - Approved by Review Board
NO._G005	RF Compatibility	B. Menrad	Closed - Approved by Review Board
NO._G006	Risk Triggers	B. Menrad	Closed - Approved by Review Board
NO._G007	Orbit Determination	E. Corderman, D. Tracewell	Closed - Approved by Review Board
NO._G008	Detailed FDF Requirements	E. Corderman	Closed - Approved by Review Board
NO._G009	Attitude Sensor Calibration Approach	D. Tracewell	Open – Issues being addressed with GLAST Systems Team
NO._G010	FDF Launch Criticality	E. Corderman, D. Tracewell, R. Mahmot	Closed - Approved by Review Board
NO._G011	Proprietary Issue	R. Mahmot	Closed - Approved by Review Board
NO._G012	Command Encryption	R. Mahmot	Closed - Approved by Review Board
NO._G013	Star Catalogue Updates	R. Mahmot	Closed - Approved by Review Board
NO._G014	Common Ground System Tool	R. Mahmot	Open - SSMO and GLAST Project Office must define approach (SOARS)
NO._G015	MOC Storage of Frames vs. Packets	R. Mahmot	Closed - Approved by Review Board
NO._G016	Manual Method of ToO Execution	R. Mahmot	Closed - Approved by Review Board
NO._G017	"Hot Bench" Usage	M. Goans	Open – Response sent to Review Board

Ground System Requirements Flow



The "Element" Functional & Performance Requirements Document (or similar document) represents a 4th level of the GLAST project requirement hierarchy

Ground System Documents Controlled by GLAST Project CCB

Document Name	Baseline
	Date
Mission Operations Concept Document	March 2002
Ground Data System Mission Assurance Requirements	July 2003
Ground System Requirements Document	July 2003
GLAST Project Service Level Agreement	.Target date August 2004
Ground System Implementation Plan	Target date August 2004
GSSC Functional Requirement Document	December 2002
GLAST Mission Operations Center and Operations Support Surveillance Plan	June 2004
Statement of Work for the GLAST MOC and MOC Support	May 2003
GLAST Database Format Control Document	Target date September 2004

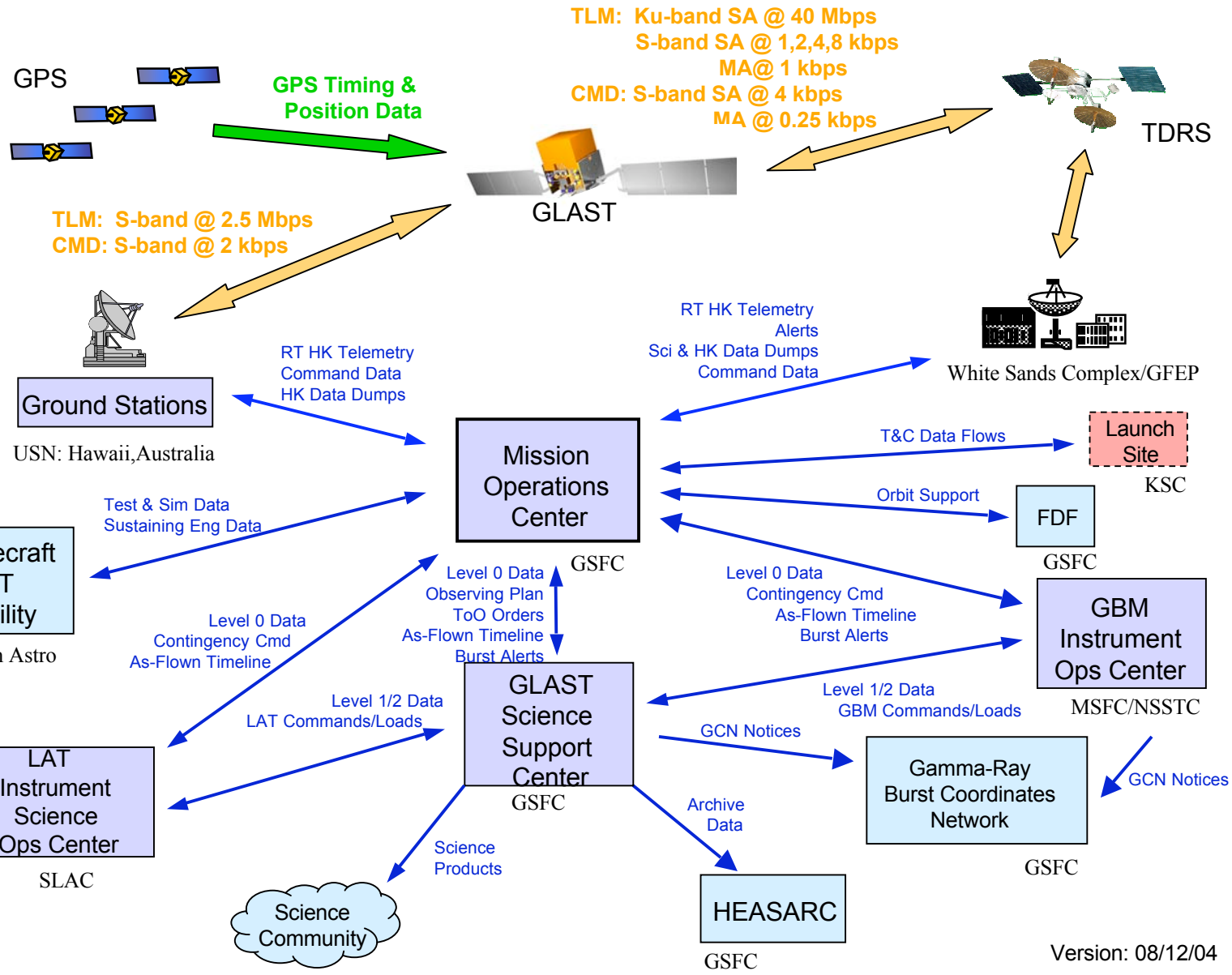
Ground System CCB Documents

Document Name	Baseline	Status
	Target Date	
MOC Functional & Performance Requirements	GSDR-2 mos.	Document in review by GS CCB
MOC Design Specification Document	GSDR – 1 month	Document to be baselined after GSDR
DB Format & Naming Convention	GSDR	Document in review by GS CCB
MOC Security Plan	GSDR	
Operations Data Products ICD	GSDR + 2 mos.	Document in review by GS CCB
MOC-Backup GS ICD	GSDR + 2 mos.	Initial draft under internal review
Mission Operations Readiness Plan	MOR + 1 mo.	
MOC Transition Plan	Launch + 8 mos.	
Operations Agreements	ORR – 2 mos.	
Database Format Control Document (DFCD)	GSDR – 1 month	Document in review by GS CCB
Ground System Test Plan	GSDR – 1 month	Draft under internal GS review
GLAST Mission Operations Agreement: Roles & Responsibilities	GSDR – 1 month	Initial version under going re-write to include GS CCB and GS DRB

Ground System CCB Documents (cont.)

Document Name	Baseline Target Date	Status
Flight Dynamics Facility to MOC ICD	GSDR – 1 month (initial version)	Baselined by GS CCB on July 04
GLAST Portable Spacecraft Simulator (PSS) Requirements Document	March 2004	Draft submitted to GS CCB
Portable Spacecraft Simulator Users, Operators and Maintenance Manuals	GSDR + 3 months	Waiting on drafts
GFEP Design Document	September 2004	Waiting on draft
GFEP to WSC ICD	August 2004	Draft submitted to GS CCB
GFEP to MOC ICD	July 2004	Draft submitted to GS CCB
GFEP Functional And Performance Specification Document	June 2004	Document in review by GS CCB
GFEP Requirements Document	September 2004	Draft submitted to GS CCB
GLAST MOC to WSC Memorandum Of Agreement	January 2005	Waiting on draft

Ground System Architecture



Architecture Summary

- ***Space Network (TDRS, WSC, DAS, SWSI)***
  - *Provides communications support for all science data at 40 Mbits/s to WSC; also, spacecraft alarm messages, and Housekeeping data*
  - *Provides communications support for Burst Alert Messages, spacecraft alarm messages, and Housekeeping data*
  - *Provides continuous MA return service via the Demand Access Service (DAS)*
  - *Provides schedulable MA forward, SA forward and return also available*
- ***Ground Station Network (USN): Backup and Contingency***
  - *Provides backup space-to-ground communications support*
    - *TDRSS Ku-band and S-band*
  - *Performs RS-decoding, reports statistics to MOC, sorts data by virtual channel and time stamps data at the frame level*
  - *Forwards real-time data to MOC; records dump data and forwards to MOC*
  - *Provides approximately 20 contact opportunities per day (using primary USN sites in Hawaii and Australia)* - need approximately 6 per day

Architecture Summary (cont.)

- ***Mission Operations Center (MOC)***
  - *Provides real-time command & control, telemetry processing, and data monitoring and analysis*
  - *Supports (and design based on) the traditional 8x5 operations model*
  - *Provides mission planning, TOO handling, Level 0 data processing*
  - *Serves as single point of commanding for the ground system*
  - *Generates As-Flown Timeline to document what observatory actually accomplished (e.g., reflects autonomous repointing)*
  - *Employs design based on Swift MOC architecture (e.g., ITOS)*
- ***Flight Dynamics Facility (FDF)***
  - *Supports the Pre-launch flight dynamics analyses activities*
  - *Provides and independent validation of in-flight GPS orbit solutions*
  - *Generates TDRS ephemeris data to support upload of TDRS orbit vectors via the MOC*
  - *Provides attitude validation & sensor calibration*
  - *Provides contingency orbit determination as needed*

Architecture Summary (cont.)

- ***GLAST Science Support Center (GSSC)***
  - *Supports the Guest Investigator program*
  - *Reviews commands and memory loads from the IOC's for their impact on the observing timeline (science-level constraint checking)*
  - *Provides the MOC with an observing timeline based on accepted Guest Investigator proposals, IOC inputs, and science requirements*
  - *Generates Target of Opportunity orders approved by the Project Scientist and forwards to the MOC*
  - *Ingests data from the MOC (level 0) and IOC's (Level 1/2) for distribution to the science community and mission archives at the HEASARC*
  - *Distributes analysis tools to the science community*
- ***HEASARC***
  - *Provides long-term permanent archive for GLAST*
  - *Receives data products from GSSC*

Architecture Summary (cont.)

- ***LAT Instrument Science Operations Center (LISOC)***
  - *Performs higher level data processing (Level 1 & 2) using Level 0 data provided by MOC, and provides Level 1 data products to the SSC*
  - *Archives and distributes science data products (for LAT collaborations)*
  - *Supports instrument calibration activities*
  - *Performs instrument activity planning, trending & performance analysis and anomaly investigation*
- ***GBM Instrument Operations Center (GIOC)***
  - *Performs higher level data processing (Level 1 & 2) using Level 0 data provided by MOC, and provides Level 1 data products to the GSSC*
  - *Supports instrument calibration activities*
  - *Performs instrument activity planning, trending & performance analysis and anomaly investigation*
  - *Provides a Burst Alert Processor Archives and distributes science data products (for GBM collaborations) to be located with the GSSC (Bldg 2) for performing additional processing of Burst Alert Messages to improve location information*

Architecture Summary (cont.)

- ***Gamma-Ray Coordinates Network (GCN)***
  - *Receives Burst Alert Messages via the Burst Alert Processor (BAP) resident with the GSSC and the GIOC (backup)*
  - *Forwards immediately to the science community*
- ***Spacecraft I&T Facility***
  - *Provides access to spacecraft and instruments during pre-launch testing and operations simulations activities*
  - *Provides flight software maintenance and general sustaining engineering support (option in Spectrum contract)*
  - *Hosts copies of the MOC system, and the FOT*
- ***GLAST Front End Processor (FEP)***
  - *Captures (at WSC) real-time and playback housekeeping and science data from TDRSS Ku-Band service*
  - *Forwards real-time data to the MOC*
  - *Transfers science data to the MOC post pass*

GSRD Requirements Statistics

Ground System Element	*Number of Requirements*
Mission Operations Center Requirements	*173*
Flight Dynamics Facility Requirements	*11*
LAT IOC Requirements	*52*
GBM IOC Requirements	*52*
GSSC Requirements	*46*
GCN Requirements	*7*
HEASARC Requirements	*6*
Ground Station Requirements	*44*
Space Network Requirements	*57*
Ground Communication Requirements	*14*
System Requirements	*37*
Spacecraft I&T Facility Requirements	*10*
KSC Requirements	*10*
GFEP	*62*
TOTAL	***581***

Programmatics

Configuration Control is maintained throughout the development and operations phases through a coordination of ground system and element level CM systems

- ***Ground System CCB***
  - *Comprised of reps from each ground system element and Project*
  - *Chaired by GS & Ops Manager*
    - *Configuration Management Officer (CMO) identified*
  - *Offers change control and version tracking for*
    - *Ground system level CCRs*
    - *Key ground system and element level documents*
    - *MOC operations products*
  - *Uses*
    - *Project provided on-line system for CCR management*
    - *Docushare as document repository*
    - *CVS (hosted by Goldbelt Orca/Omitron) as ops product repository*
  - *To be transitioned over to Operations CCB at L+60*

Programmatics (cont.)

- ***Operations CCB***
  - *Comprised of key members from the ground system elements and project*
  - *Chaired by Mission Director*
  - *Will use same repositories as the Ground System CCB*
- ***Element Internal CM***
  - *Documented in Element CM Plan (where applicable)*
    - *All changes to controlled products reviewed*
    - *Any requirements/scope or interface changes elevated to GS CCB for approval (criteria detailed in the Ground System Implementation Plan)*
  - *Offers change control and version tracking for*
    - *Element internal documentation*
    - *Element operations products*
    - *Element software including configuration files and data files (e.g., USN upgrades)*
  - *Provides the ability to reproduce the software environment (where applicable) at any past moment in time*

Programmatics (cont.)

- ***Quality Assurance***
  - *Risk Management System In-Place*
    - *Code 300 System Assurance Engineer provides support for GLAST*
    - *Risks identified, tracked, and closed as appropriate*
  - *DR System In-Place*
    - *DRs written on discrepancies encountered throughout test program*
    - *DR Tracking is maintained through a coordination of ground system and element level QA systems.*
  - *Ground System Level Process*
    - *DR Review Board chaired by Ground System Engineer*
    - *Uses project provided on-line system for DR management*
    - *Closes out DRs to element level where applicable*
  - *Quality Assurance Processes documented in the "GLAST Ground System Implementation Plan"*

Programmatics (cont.)

- ***Report Development Progress***
  - *Provide weekly status reports to GLAST Project Office identifying progress and any issues/concerns and any risk items*
  - *Track monthly contractors cost/schedule against plan; report variances*
- ***Routine Meetings***
  - *Working groups – GOWG*
  - *Staff meetings – Project Staff; Ground System Staff; MPSR*
  - *Technical Interchange Meetings (TIMS)*
  - *Ground system CCB meetings*
- ***Formal Reviews***
  - *Ground System Requirements Review*
  - *Ground System Design Review*
  - *GLAST Mission Critical Design Review (September 21-22, 2004)*
  - *Mission Operations Review (October 18, 2005)*
  - *Operations Readiness Review (October 19, 2006)*

Programmatics (cont.)

- ***Summary of Ground System Reviews:***

Ground System Element	Date Held (PDR)	Date Held (CDR)
System Requirements Review	*7/22/03*	
GLAST Burst Monitor IOC	10/31/03	*6/29/04*
GLAST Science Service Center	*11/24/03*	*7/13/04*
Flight Dynamics Facility	*02/10/04*	*7/15/04*
Mission Operations Center	*12/15/03*	*7/21/04*
Universal Space Network	----------	*7/27/04*
GLAST Front End Processor	*02/12/04*	*7/29/04*
LAT Instrument Science Operations Center	*03/02/04*	*8/03/04*

Integrated Schedule

Ken Lehtonen & Howard Dew Code 581

GLAST Ground System / Mission Operations Schedule

Version (8/12/04)